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ABSTRACT

A research study and the intent and purpose of its experiments are outlined to support the premise that "a change in the color of an environment will bring a change in the pattern of human movement within that environment". Experiment cited is concerned with the color variables of light beige and dark brown in a controlled environment with museum visitors used as subjects. The study is involved with observing the effect of color changes on--(1) group behavior patterns, (2) the amount of movement, (3) movement patterns, and (4) time or traffic flow rates. A reference list is given. (TG)

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HUMAN MOVEMENT AS A FUNCTION OF COLOR STIMULATION

Rajendra K. Srivastava, Ph.D.

Thomas S. Peel, AIA

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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THE ENVIRONMENTAL RESEARCH FOUNDATION
2700 WEST SIXTH STREET
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Preface

The present study is second in a series of investigations planned by The Environmental Research Foundation under its program "Human Movement and Architecture." This study along with the earlier study "Footsteps as a Measure of Human Preference" by Dr. Robert Bechtel has laid the foundation for future investigations.

The next study in this series will attempt to investigate how color, subject matter of decoration, and two and three dimensional stimulus objects influence patterns of foot movement while standing and walking.

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The authors of this report are indebted to Mr. D. S. Shivananda for his painstaking effort at collecting and analyzing data.

Special thanks are due to Mr. Bret Waller, curator of the museum of art, University of Kansas, Lawrence, Kansas, for his kind permission to conduct the study in the museum, procuring Japanese paintings to be used in the study and for his assistance in numerous other ways which made this study possible.

Dr. Robert Bechtel has been a constant source of help from the beginning to the end of this project. His suggestions, comments and criticisms have been valuable. His help and cooperation are gratefully acknowledged.

The authors commend the efforts of Mrs. Margaret Boaz and Miss Annette Wipf. Annette typed the rough draft with great patience. Margaret Boaz revised the manuscript and typed the final report. Without her efforts, this report might not have come into existence.

R. K. S.
T. S. P.

Topeka, Kansas
May 1968

Introduction

Color has intrigued man, perhaps since his advent on earth. He has tried to understand and explain the phenomenon of color in numerous ways. For the ancient mystics color was akin to supernatural and not just a physical fact. Early in history the thinking of mankind was that different colors had different symbolic attributes affecting the life of man on earth in various ways. To some of these ancient philosophers and physicians color influenced health and well being of man. Color was considered helpful in diagnosis and treatment. Color had medicinal properties. Gems and other colorful precious stones were worn not so much for ornamentation but for curing diseases, bringing good luck and modifying human actions. Various plants and herbs were found to have medicinal properties and it was thought that these medicinal properties were contained in their colors and not in their chemicals. Color healing may sound superstitious, but it is present even today in the form of x-ray, infrared, and ultraviolet ray treatment with sound scientific results. Color healing in its unscientific form continued to be practiced until recently.

The modern viewpoint toward the effect of color is skeptical. However, there is little doubt that color does affect the human organism in various ways. Ignorance still prevails as to the ways and forms in which this effect takes place. One is not sure if color alone exerts the observable effects or whether its effects are compounded with the influence of other physical agents with which it associates. Little information is available with regard to the respective role of visible and invisible

colors. Much of the available scientific evidence indicates that color affects the physical body. Is it also possible that color affects psychological processes, human actions and observable and unobservable behaviors? There is some suggestion that this is so. Color shock in Rorschech cards is a well known phenomenon. Jaensch's diachotomy of humans into cold color and warm color personalities may have some germ of truth.[1] Feelings of pleasantness and unpleasantness in surroundings of different colors is not a hypothetical assertion. Various colors of spectrum are supposed to bring different moods and reactions. According to Ross[2] gray, blue and purple are best associated with tragedy; and red, orange and yellow with comedy.

In spite of all this, research on the psychological aspects of color is inadequate. A few leading studies in this field have been able to demonstrate that there is a definite relationship between color and human reactions but research is far from specifying the nature of this relationship. Brighouse[3] measured human reactions under colored lights and found that reations were 12 per cent greater than normal under red light while the reactions were slower under green light. Harmon's[4] observations of

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[1] Jaensch, E. R., Eidetic Imagery, Kegan Paul, Trench, Trubner, & Co., London, 1930.

[2] Ross, R. A., referred by Birren, F., Color Psychology and Color Therapy, University Books, Inc., New York, 1965, p. 141.

[3] Brighouse, G., referred by Birren, F., Color Psychology and Color Therapy, University Books, Inc., New York, 1965, p. 142.

[4] Harmon, D. B., "Lighting and the Eye," Illuminating Engineering, September, 1944.

human responses under conditions of various colors in the environment suggest that mental and visual tasks are better performed with soft and deep colors.

Probably the most significant work in this field has been done by Goldstein. He writes: "It is probably not a false statement if we say that a specific color stimulation is accompanied by a specific response pattern of the entire organism."[5] He refers to a case of a woman with cerebellar disease whose symptoms of falling and unsteady gait were more pronounced when she wore red clothes and were normal when in green or blue clothing.[6] It was also noted that under red light outstretched arms spread away from each other while under green light, they moved toward each other.[7] In Goldstein's opinion these reactions represent subjects' inner feelings of obtrusion, aggression and excitation by red and of withdrawal and retreat by green. "The inner feelings represent the psychological aspect of the reactions of the organism."[8]

Other reactions such as judgments of time, length and weight have also been demonstrated to be influenced by color. Goldstein states that under red light time is likely to be overestimated and under green or blue light it is underestimated.[9] Similarly "Estimation of the length

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[5]Goldstein, K., quoted by Birren, F., Color Psychology and Color Therapy, University Books, Inc., New York, 1965, p. 144.

[6]Goldstein, K., "Some Experimental Observations Concerning the Influence of Color on the Function of the Organism," Occupational Therapy and Rehabilitation, June, 1942.

[7]Goldstein, K., Ibid.

[8]Goldstein, K., Ibid.

[9]Goldstein, K., Ibid.

of sticks based on hand touch stimulation is much less correct in red light. The threshold is lower in green and enlarged in red stimulation."[10] Also weights are judged heavier under red light and lighter under green light. In general, red is found to increase the level of response and green to subdue although after effects are reversed. From these findings Goldstein makes the following generalization: One could say "red is inciting to activity and favorable for emotionally determined actions; green creates the condition of meditation and exact fulfillment of the task. Red may be suited to produce the emotional background out of which ideas and actions will emerge; in green these ideas will be developed and actions executed."[11] This statement conveys the idea that colors have definite effects which may be universal. However, the case does not seem to be so. Deutsch's[12] work has demonstrated that color does affect human mood and reactions but those effects are not the same for everyone. The same color may excite one and depress the other. The observable effect depends upon the extent to which a particular color appeals to a particular individual. He suggests, therefore, that in treating mental patients one may select colors on individual basis.

To control and identify reactions on mental patients color has been used by many other psychiatrists. Rubin and Katz[13] report of subjects

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[10] Goldstein, K., Ibid.

[11] Goldstein, K., quoted by Birren, F., Color Psychology and Color Therapy, University Books, Inc., New York, 1965, p. 144.

[12] Deutsch, F., "Psycho-Physical Reactions of the Vascular System to Influence of Light and to Impression Gained Through Light," Folia Clinica Orientatia, Vol. I, 1937.

[13] Rubin, H. E., and Katz, E., "Auroratone Films for the Treatment of Psychotic Depressions in an Army General Hospital," Journal of Clinical Psychology, October, 1946.

who were shown films with mobile color effects combined with music, in a relatively successful attempt to bring them out of their depression. Some experiments run in Worchester State Hospital indicated that on mental patients magenta and blue have quieting effect, yellow has stimulating effect, red has more stimulating effect than yellow. From these studies and many other less systematic studies at least one thing is clear - color does influence human psychological and physical reactions and in turn may have far reaching effects on personality. In general, it is also indicated that warm colors such as red increase the level of responding while cool colors such as blue and green have subduing effect.

Color as an Environmental Variable

Color has physical properties and is an environmental variable. It is probably one of the most significant variables in an environment, firstly because it is constantly with us, and secondly it has been shown to have far reaching effects upon our reactions. For these reasons it appears very important that more systematic empirical understanding should be obtained than has been obtained in the past regarding how different colors affect different human reactions. An understanding of such relationship will provide us with an empirical basis of choosing appropriate colors for different environments that we use. Until now color specifications for different kinds of environments such as hospitals, homes, churches, schools, etc. have been based upon speculations with regard to their effect on human reactions. For example, Birren[14] has made some generalizations about the effects of major hues and has given speculative suggestions about the appropriate colors for various environments.

In summary form, his generalizations about the effects of various hues are as follows:

Red is a dynamic color. It distracts the equilibrium of the body. It raises blood pressure and pulse rate followed by a reversal of these effects. It is exciting and it increses restlessness and nervous tension. Modified forms of red are beautiful and expressive, universally appealing and deeply emotional. It helps to distract attention from within and to

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[14] Birren, F., Color Psychology and Color Therapy, University Books, Inc., New York, 1965, pp. 258-266.

direct it outward.

Orange has basically the same qualities as red. It has high appetite appeal.

Yellow has a favorable effect upon human metabolism.

Green is pacific and tends to reduce nervous and muscular tension. It represents a withdrawal from stimulus. It provides an ideal environment for sedentary tasks, concentration and meditation.

Bluish-green is both pleasing and "livable."

Blue is antithetical to red. It decreases hormonal activity, lowers blood pressure and pulse rate with a reversal of these effects. It is low in attention-value, sedate and restful. It is generally a favorite universally.

Purple is biologically neutral and has a dominant aesthetic appeal.

White is a balanced color and emotionally neutral.

Black is negative and emotionally neutral.

Gray is passive and emotionally neutral.

His color specifications for various environments are as follows:

Hospitals - The lobby or reception room should have a variety of hues both warm and cool, the objective being to avoid any one specific mood. Warm tones are desirable for the maternity division where a will to get well is the spirit to be encouraged. Cool tones are not appropriate for chronic patients who should be reconciled for more prolonged stay.

In surgery,walls should be green, or bluish-green to overcome glare, relax the eye and complement red hue of blood and tissues. Lavender, cool yellows and yellow-greens should be avoided because they cast unfavorable reflections.

Schools - Elementary school rooms should have warm tones of yellow, peach and pink because they are stimulating. In secondary grades, tones of green-blue-green, blue and gray are recommended to avoid distraction and aid mental concentration.

Airplanes and Ships - Moderately warm tones are recommended because they reduce apprehension or nervousness and counteract the blurring effect of expanses of blue, and are moderately stimulating. For variety and harmony blue-green may be introduced in carpeting or upholstery.

Homes - Warm tone should be used in living rooms for convival mood, peach in dining room for appetizing effect, cool tones of green or turquoise in kitchen for shortening the apparent passage of time, yellow in basement or playroom which is devoid of natural light, deep hues in den or library to avoid distraction, pink in bathroom to give skin a luxurious glow. Bedroom in any light tint. Strong contrasts and large patterns may encourage early rising. Late sleepers will value plain areas and less aggressive tones.

In the absence of sufficient empirical information these speculations cannot be taken very seriously. And, therefore, there is a need for systematic exploration of ~~the effect~~ of color in various environments on various human behaviors. The present study is a step in this direction.

Aims and Purposes

The purpose of the present study is to demonstrate that a change in the color of an environment will bring a change in the pattern of human movement within that environment.

Independent Variable

To accomplish the purposes of the study color has been chosen as the independent variable and two variations of it have been considered. The two variations are light beige and dark brown. These colors have been incorporated in a real environment which will be described in a later section.

Dependent Variable

As indicated earlier the dependent variable is human movement. It will be measured by a special device called the hodometer,[15] which was developed by The Environmental Research Foundation. This device has been used in earlier studies of human movement by Robert Bechtel.[16,17]

Human movement has been defined as the successive footfalls on the plane of a physical-architectural environment. The following movement measures will be obtained.

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[15] For a description of Hodometer, see Bechtel, R., Footsteps as a Measure of Human Preference, The Environmental Research Foundation, Topeka, 1967.

[16] Bechtel, R., Ibid.

[17] Bechtel, R., "Human Movement and Architecture," Trans-Action, May, 1967, pp. 53-56.

a. Area - amount of square feet covered

b. Elevation - number of footsteps taken

c. Time - amount of time spent

d. Pace - elevation/time

e. Density - elevation/area

f. S.D. - standard deviation

Research Design

Two experiments were conducted simultaneously. The purposes and the research designs of both the experiments were the same. The two experiments differed in the kind of subjects used, and in the kind of some of the data that could be obtained with each kind of subject. The first experiment used those adults as subjects who came to the museum to view the exhibits singly, in pairs, or in trios, and had absolutely no knowledge of the experiment. The second experiment used adult college students who came to participate in the experiment singly and had knowledge of the experiment although they were unaware of the purpose and method of the experiment. They were also paid for their participation at an agreed rate.

The research design involves comparison of movement data obtained during the period when the experimental room was colored light beige with movement data obtained during the period when the experimental room was colored dark brown. Except for variations in color, all other variables in the experimental setting were kept constant. The subjects under two experimental conditions (color) were assumed to be the random sample of the population and thus comparable. The following diagram illustrates the research design.

Figure 1

Research Design

	Group I	Group II
	Experimental Condition Light Beige Color	Experimental Condition Dark Brown Color
Experiment I	N = 301	N = 301
Experiment II	N = 30	N = 30

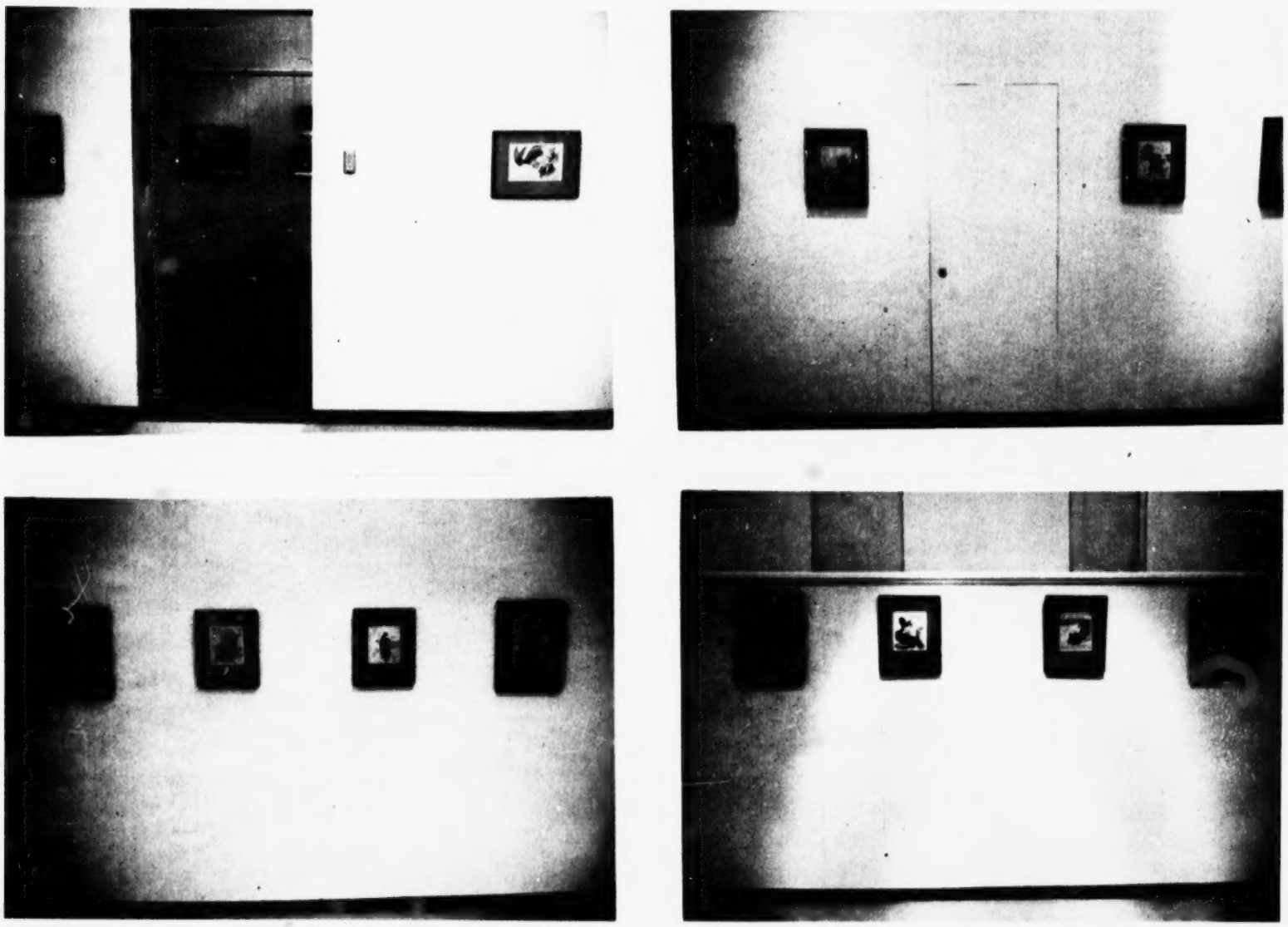
Experimental Setting

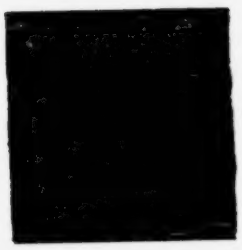
The experiment was conducted in a display room at the Spooner Thayer Museum of Art at The University of Kansas, Lawrence, Kansas. The plan of the room can be seen in Figures 3 to 6. This room was considered as the experimental architectural environment. A photograph of this room and examples of color change in it are given in Figure 2. The room was arranged in such a way that it appeared to be serving the same purpose as other rooms in the museum (i.e., a display room for art objects). Japanese paintings were displayed on the walls of the room. It was thought that Japanese paintings would be relatively novel to subjects and would attract subjects into the experimental room. Fourteen paintings of relatively small size were displayed. Three walls had four paintings each and one wall with entrance door had only two paintings. The size of paintings was kept small to allow the color of the room to have maximum stimulus value. The existing windows in the room were covered with cardboard to control the variables of natural light in the room. These coverings had the same color as that of the room.

For the first group of subjects the walls of the room were colored light beige and for the second group of subjects the walls of the room were colored dark brown. The color of the rug on the floor was also changed to approximate the color of the walls under both conditions. All other variables within the room were maintained constant during both experimental conditions including the position, direction and intensity of artificial illumination, and the paintings and their location.

Figure 2

Photographs of the Experimental Room and Examples of the Two Colors Used in the Expe iment





Light Beige

Dark Brown

The hodometer cabinet was placed in a closet adjacent to the experimental room, both connected by a door. The door remained closed keeping the hodometer and the experimenter hidden from the subjects. In the ceiling a convex mirror was placed in such a way that it allowed the experimenter hidden in the closet to see everything that was going on in the experimental room.

Methodology

Experiment I.

Natural museum visitors served as subjects. They had no knowledge of the experimental arrangements. It was assumed that these subjects constituted the random sample of the population.

A total of 602 subjects, 301 in each group were used. All the visitors who came into the room singly, in pairs, or in trios were included in the sample. More than three in a group was considered a crowd and such visitors were excluded from the sample. When such a crowd entered the room the hodometer was stopped immediately by the experimenter. Under both experimental conditions the number of singles, pairs and trios and male and female was kept the same. This data about subjects is given in Table I.

Table I

Number of Singles, Pairs and Trios, Males and Females, and Number of Subjects in Each of the Two Experimental Conditions

	No. of Singles, Pairs and Trios	No. of Subjects
Singles		
Male	54	54
Female	23	23
Total	77	77
Pairs		
Male-Female	34	68
Male-Male	11	22
Female-Female	28	56
Total	73	146
Trios		
Male-Male-Male	1	3
Female-Female-Female	12	36
Male-Female-Male	2	6
Female-Male-Female	11	33
Total	26	78
TOTAL	176	301

Originally, it had been decided to have 300 subjects in each of the two experimental conditions. The number 301 was the closest approximation that could be achieved. When the number 301 was achieved for Group 1, collection of data was stopped. The color of the room and rug was changed from light beige to dark brown and collection of data on Group 2 was started, and continued until the number of singles, pairs, trios, male and female was the same as was for Group 1. From past experience it was felt that about 300 subjects in each group would give an adequate picture of the overall movement pattern.

Data was collected everyday including Saturdays and Sundays during the time the museum remained open, which was 9:00 a.m. until 4:30 p.m. on Monday through Saturday and 1:00 p.m. until 4:30 p.m. on Sundays. An observer assisting the experimenters in collecting data was always present in the museum during the period of data collection. He sat in the closet, copied data from the hodometer onto record forms, observed the visitors coming into the experimental room and stopped the hodometer whenever it was felt necessary to do so. During the period data was not collected the hodometer was switched off.

Experiment II.

Although the main purpose of Experiment II was the same as that of Experiment I, it had two additional aims:

1. To see whether or not subjects especially brought to participate in the experiment produced movement patterns similar to those produced by natural museum visitors who had no knowledge of the experiment.

2. To determine the subjective estimate of the size of the experimental room made by subjects and to see whether or not their subjective estimates correlated with their movement patterns.

There were 60 subjects in all, 30 in each group. Of these 30 in each group, 7 were females and 23 were males. Request for subjects to participate in an experiment was made by placing a notice on the bulletin boards in the departments of psychology and education at The University of Kansas, Lawrence, Kansas. The notice informed the prospective subjects that the experiment intended to determine their reaction to Japanese paintings and that they would be paid for their participation in the experiment. Some of the subjects were personally contacted by the experimenters. They were also given the same information that was posted on the bulletin boards. No special criteria for selection of subjects was used. All the subjects were university students and it was assumed that they represented a random sample of the university student population. The first 30 subjects who reported for the experiment constituted the first group. It so happened that there were 23 male and 7 female subjects. When the color of the room and rug was changed and data on the second group of subjects was starting to be collected, exactly 23 male and 7 female subjects were used to match the two groups on the number of subjects and sex.

The setup of the experimental room and the method of movement data collection for Experiment II was the same as for Experiment I.

Because of the special nature of subjects in Experiment II the way the subjects were sent in the experimental room differed from the way they went there in Experiment I. In Experiment I the visitors who felt like going into the room went inside, stayed there as long as they wanted

and did whatever they pleased. All the time the hodometer remained switched on except when more than three persons were present in the room at one time. In Experiment II one subject at a time was sent into the experimental room. He was sent in when there was no person present in the room. The hodometer was turned on when the subject was about to enter the room and switched off when he left the room. During the period the subject was in the room no one else was allowed to go inside. The experimenter sat outside the room in a corner near the hodometer control panel to switch the machine on and off as need be. He could not be seen there by the subject in the room but he could see the entrance to the experimental room. As soon as he saw that someone was about to enter the experimental room he approached him and told him that an experiment was going on in the room and that he would appreciate it if the visitor would wait for a few minutes until the subject left the room. When the subject left the room the experimenter stopped the hodometer by switching it off, and allowed other visitors to go into the room. Thus movement data for individual subjects was obtained.

The subjects were not told the real purpose of the experiment. When they came to the museum for the experiment, the experimenter received them and gave them the following instructions: "The purpose of this experiment is to determine your reactions to the Japanese prints. Go into the room, look at all the prints. Take as much time as you need in the room and form your opinion about the prints. As soon as you have done this leave the room and come back to me. I will then give you a form on which you will record your reactions. There will be no one

else in the room with you to influence your opinion. Try to be honest and frank in your opinion." When the subject came out of the room the experimenter gave him the questionnaire to fill in. A copy of this questionnaire is given in Appendix A. This questionnaire was divided into two parts. The first part asked the subjects' opinions of the Japanese prints, consistent with what the subjects had been told about the purpose of the experiment. Part II asked two questions. First question asked their opinion about the appropriateness of the size of the exhibition room. This question too did not deal with the real purpose of the experiment. The second question was of direct concern to the experiment. It asked the subjects' estimates of the size of the room. Eleven estimates put in random order for each subject were provided along with a blank space. Subjects were asked to underline that estimate with which his estimate corresponded. In case his estimate was different from all the ones given in the questionnaire, he could write his in the blank space.

It was assumed that while the subject was in the room he would have an unconscious feeling of the size of the room. This he could report as his subjective estimate. The reason why the subjects were not asked to give their estimates of the size of the room while in the room was to avoid the influence the immediate perception of the room might have on their judgment of its size. The interest was in obtaining the unconscious reaction of the subjects about the size of the room when it is colored light beige and when it is colored dark brown.

The first part, and the first question in the second part of the questionnaire were to hide the real purpose of the experiment from the subject.

Through the above-mentioned procedure it was possible to obtain subjects' movement patterns within the experimental room without being affected by the knowledge that they were being recorded and also to obtain their sujective estimates of the size of the room again without being affected by the knowledge that it was required.

The data for Experiment I were analyzed by means of chi-square and the data for Experiment II were analyzed by means of Analysis of Variance.

Results

The basic data for subjects in Experiment I and results of comparison of Group I and Group II on various movement measures in this experiment are reported in Table 2.

The results indicate that museum visitors in light beige and dark brown rooms behaved differently. Group II (subjects in dark brown room) in comparison to Group I took more footsteps, covered more area and spent less time in the room. It is also indicated that Group II in comparison to Group I yielded a less dense movement pattern and showed a faster pace of movement. Although all differences are significant, the most important finding is with respect to the measure of Area. Group II on the average covered just about twice as much area as Group I did. However, the two groups do not seem to differ in the distribution of density of footsteps (see Figures 3 and 4).

Figures 3 and 4 give accumulative movement patterns for Groups I and II respectively showing elevation, area, density of movement, and distribution of density of footsteps.

The basic data for subjects in Experiment II and results of comparison of Group I and II on various movement measures and on subjective estimate of the size of the room in this experiment are reported in Table 3.

The results indicate that in Experiment II subjects in light beige room and subjects in dark brown room did not differ significantly from each other either on any of the movement measures or on subjective estimate of the size of the room. The two groups also do not seem to differ in the distribution of density of footsteps (see Figures 5 and 6). Thus, in this experiment, results fail to demonstrate differential effectiveness of color on movement measures and also subjective estimate of room size.

Figures 5 and 6 give accumulative movement patterns for Groups I and II respectively showing elevation, area, density of movement, and distribution of density of footsteps.

Table 2

Basic Data and Comparison of Group I and Group II

on Various Movement Measures - Experiment I

	Movement Measures				
	Elevation	Area	Time	Density	Pace
Group I N - 301					
Total Mean	12843 42.7	2714 9.02	11486 38.1	4.73	1.12
Group II N - 301					
Total Mean	13892 46.2	5390 17.9	7954 26.4	2.58	1.75
Chi-Square	41.159	883.635	641.719		
df	1	1	1		
Significance at .01 level	significant	significant	significant		

Note: 1. Standard deviation measure for museum visitors is not possible because of impossibility of isolating individual movement patterns.

2. Chi-square for measures of density and pace not possible because this data is not in frequency form.

Table 3

Basic Data and Comparison of Group I and Group II on Various Movement Measures and on Subjective Estimate of the Size of Room - Experiment II

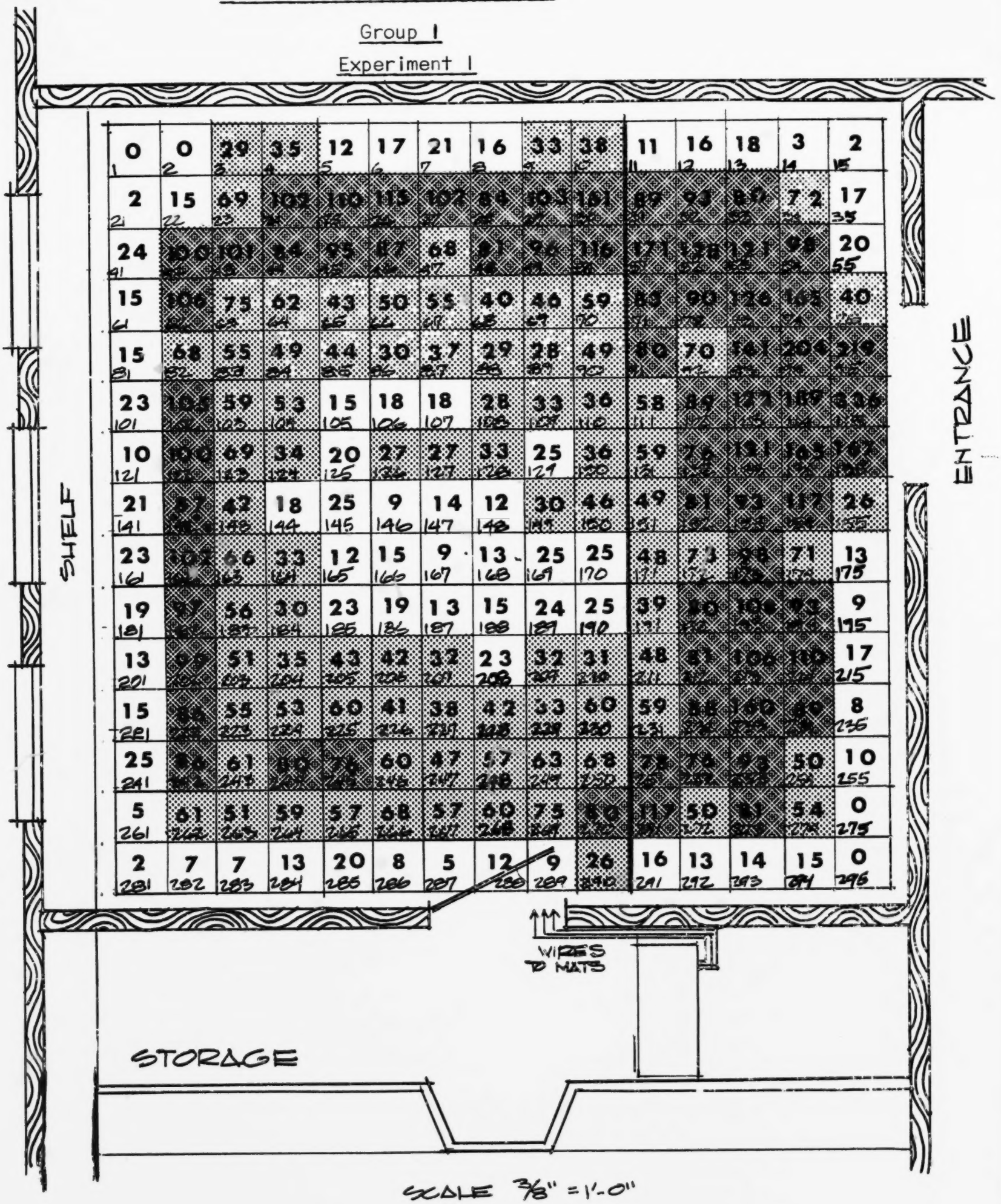
	Measures	Groups N = 30 in each Group	Totals	Means	F	df	Significance at .05 Level
Movement Measures	Elevation	Group I	3347	111.567	1.783	1,58	NS
		Group II	2889	96.300			
	Area	Group I	1884	62.800	1.251	1,58	NS
		Group II	1763	58.767			
	Time	Group I	7174	239.133	1.790	1,58	NS
		Group II	6006	200.200			
	Pace	Group I	16.136	.539	.219	1,58	NS
		Group II	15.434	.514			
	Density	Group I	51.665	1.722	1.082	1,58	NS
		Group II	48.091	1.603			
	S. D.	Group I	30.296	1.010	3.722	1,58	NS
		Group II	25.562	.852			
Subjective Estimate of Area of Room	Estimate	Group I	6886	229.533	2.147	1,58	NS
		Group II	5989	199.633			

Figure 3

Accumulative Movement Pattern

Group 1

Experiment 1



SCALE 3/8" = 1'-0"

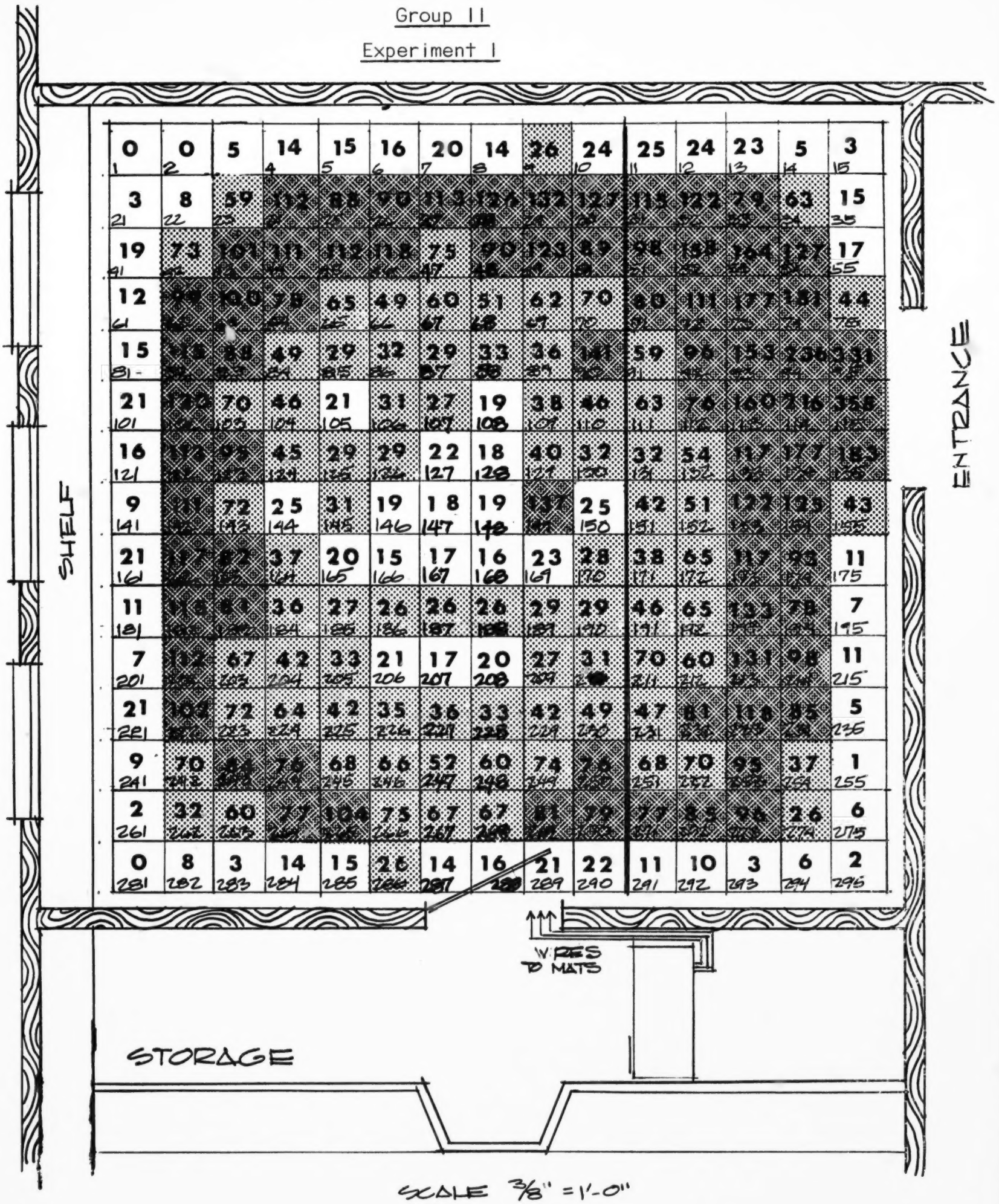
FLOOR PLAN OF MUSEUM DISPLAY ROOM
(SHOWING 12" X 12" MAT LAYOUT ON FLOOR.)

Figure 4

Accumulative Movement Pattern

Group II

Experiment I



SCALE 3/8" = 1'-0"

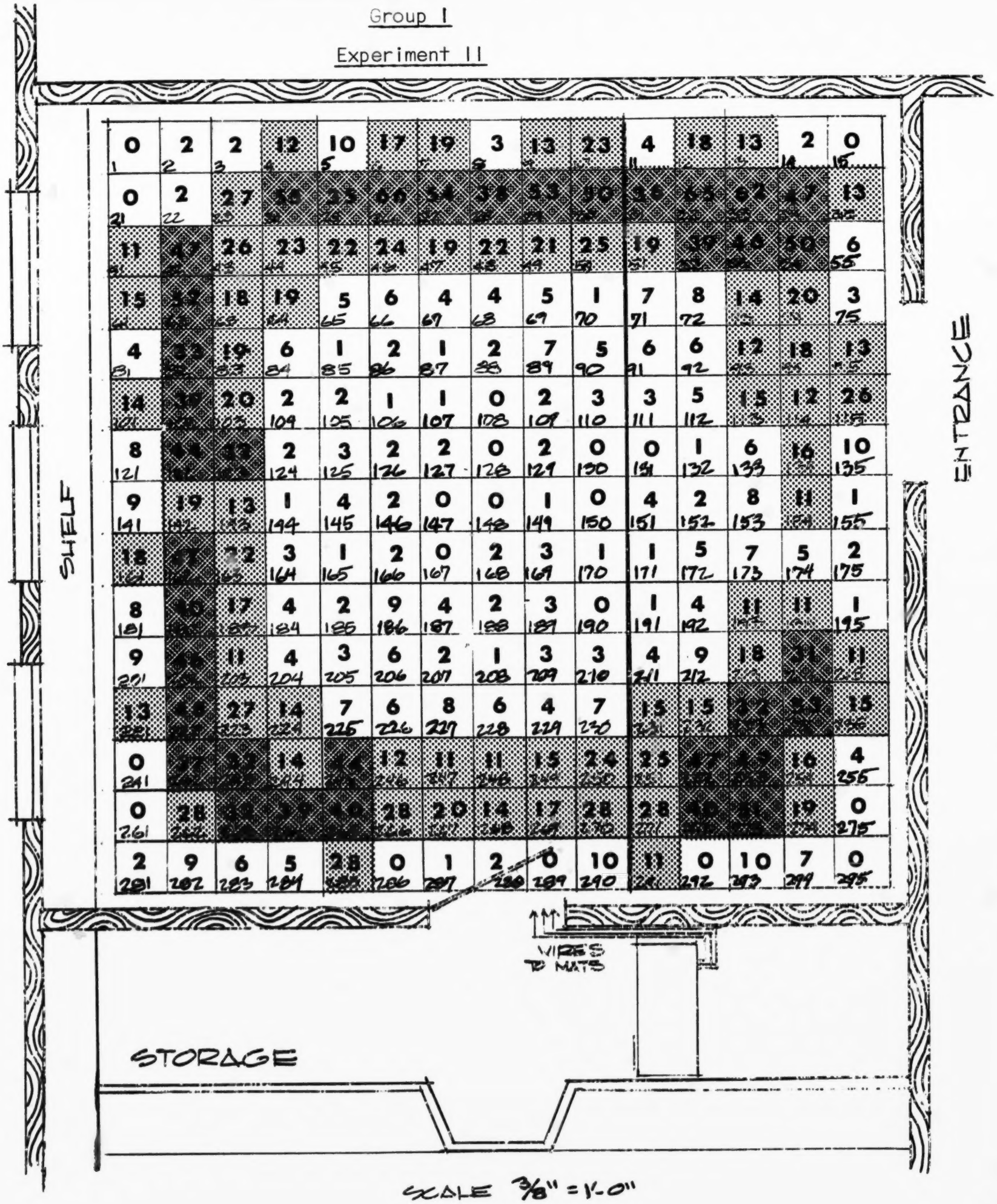
FLOOR PLAN OF MUSEUM DISPLAY ROOM
(SHOWING 12" X 12" MAT LAYOUT ON FLOOR)

Figure 5

Accumulative Movement Pattern

Group I

Experiment II



SCALE 3/8" = 1'-0"

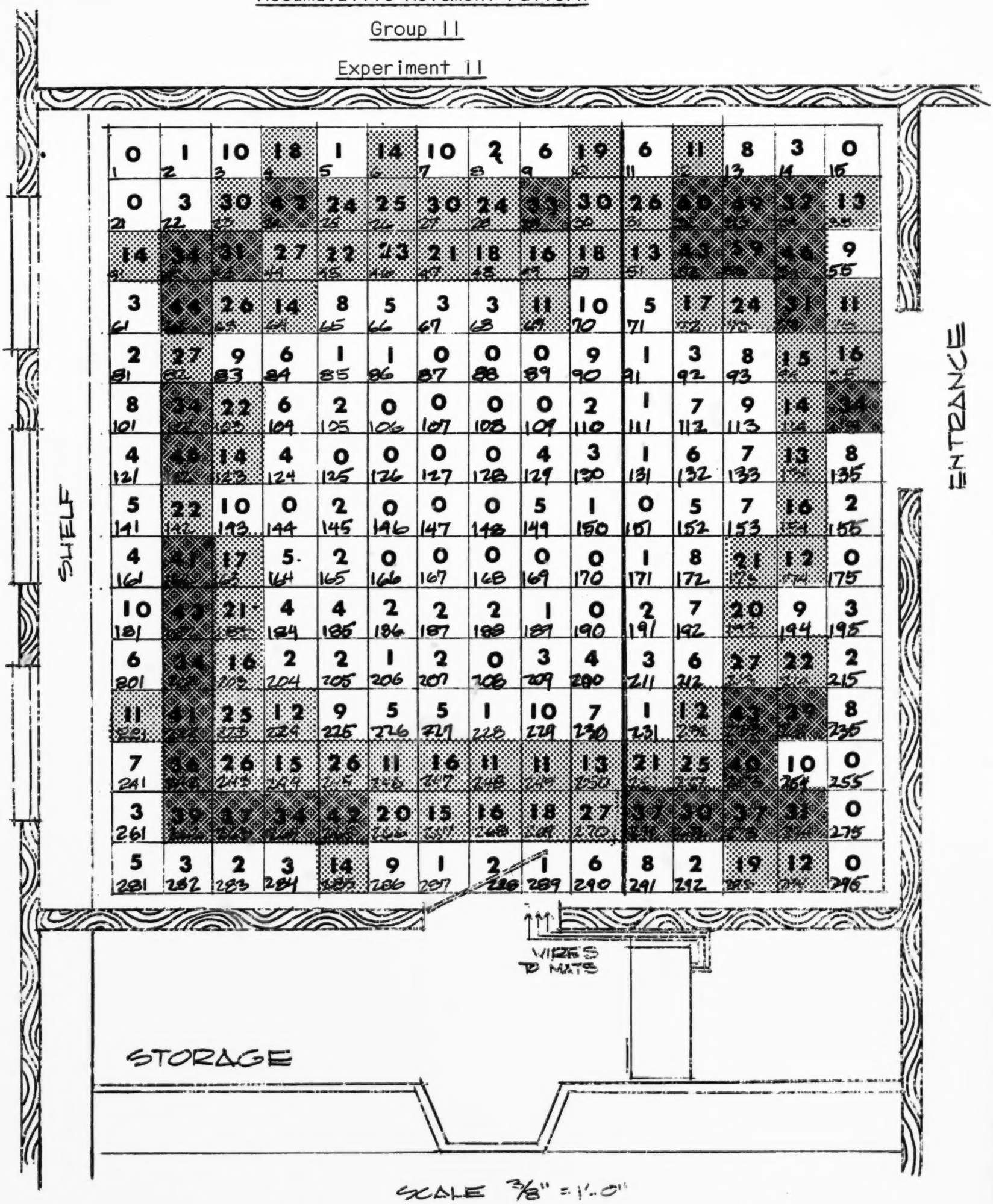
FLOOR PLAN OF MUSEUM DISPLAY ROOM
(SHOWING 12" X 12" MAT LAYOUT ON FLOOR.)

Figure 6

Accumulative Movement Pattern

Group II

Experiment II



SCALE 3/8" = 1'-0"

FLOOR PLAN OF MUSEUM DISPLAY ROOM
(SHOWING 12" X 12" MAT LAYOUT ON FLOOR.)

The results of correlations between movement measures and subjective estimate of room size are reported in Table 4. The data used are those of Experiment II. The results show no relationship between movement measures and room-size-estimates.

Distribution of the density of footsteps over switch mats has been shown in Figures 3, 4, 5 and 6 by means of shading. The unshaded areas have light density of footsteps; areas shaded light have medium density of footsteps and areas shaded dark have heavy density of footsteps. The ranges of number of footsteps within each of the three density levels for the two experiments are given below.

Table 4

Ranges of Footsteps within Three Density Areas in the Two Experiments

Areas	Range of Footsteps	
	Experiment I	Experiment II
Unshaded	0-25	0-10
Shaded Light	26-75	11-30
Shaded Dark	76-up	31-up

From visual examination of Figures 3, 4, 5 and 6 it appears that the two groups in both experiments do not differ appreciably from each other in the distribution of density of footsteps.

Table 5

Correlation Between Movement Measures and Estimate of Room Size (Data Used are Those of Experiment II)

N = 60

Correlation of Estimate With	r	Significance at .01 Level
Elevation	.050	NS
Area	.023	NS
Time	.051	NS
Pace	.051	NS
Density	.069	NS
S.D.	.098	NS

Discussion

Differential effect of color on human movement was demonstrated in case of museum visitors but not in case of individual subjects. This indicates that the two kinds of subjects behaved differently, and that for subjects in Experiment II "instructions" was a very strong variable affecting performance and simultaneously minimizing the effect of color. It is possible that the instructions given to the subjects to look at the Japanese prints and form their reactions to them made them concentrate on the prints and become relatively oblivious of the surrounding environment.

Under such circumstances the subjects were obviously reacting to prints (pseudo-independent variable) and not to color (independent) variable; hence no significant differences between the two groups were obtained in their reactions expressed either through movement or in the form of estimate of room size. This suggests that in environmental research we need to be aware of the factors which hide and even sometimes counteract the effects of environmental variables.

The fact that differential effect of color was demonstrated with museum visitors suggests two things: 1) color does affect human movement in subtle ways, and 2) its effect is demonstrated when the organism is behaving naturally and is not aware of any experimental controls.[18]

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[18] Bechtel's previous research with Hodometer too gave similar results. Subjects aware of experimental setup and subjects unaware of it yielded different movement patterns. See Bechtel, R., Footsteps as a Measure of Human Preference, The Environmental Research Foundation, Topeka, Kans., 1967.

With regard to the effects of specific colors used in the present experiment the results showed that people within dark brown color environment took more footsteps, covered more area, spent less time and yielded higher density of footsteps and faster pace of movement than people within light beige color environment. From these results it appears that the dark brown color somehow stimulated more and faster movement than the light beige color. It is still not clear why the two colors affected human movement the way they did.

There are two more questions, which also do not lend themselves to a satisfactory answer. 1) Why is it that people in a dark brown room covered more area, in fact approximately twice more than people in a light beige room? We conjectured that the dark brown room looked darker and therefore the people moved closer to the walls in order to view the paintings better, thus increasing the overall area. The data, however, do not confirm this explanation. An examination of the distribution of density of footsteps in Figues 3, 4, 5 and 6 indicates that subjects in both groups in both experiments came equally close to the walls, the heaviest concentration (density) of footsteps of both groups in both experiments remaining within 2 to 3 feet from the wall. The fact remains that in Experiment I subjects in the dark brown room stepped on twice as many floor mats thus yielding a higher overall density of footsteps as did subjects in the light beige room. Research is needed to provide a satisfactory explanation for this. 2) The second question also deals with the matter of area covered within environments of two different colors. To the naked eye, a light colored room appears to be larger than a dark colored room. If this is so, then the question is raised - why do people cover a larger area in rooms colored dark (dark brown) and a smaller area in rooms colored light (light beige)? It appears

that foot movements have a negative correlation with visual perception. Further verification of such a negative correlation is needed. And, if it is reasonably demonstrated to be true, more research will be needed to answer why it is this way.

Another significant finding of this study is that movement data do not correlate with size estimate data. The most surprising result is the lack of relationship between area covered on foot and area estimated. One would probably expect that walking through a space gives one some clues about the area or size of the space on the basis of which one then estimates the area or size. The present data suggests that, apparently, such is not the case. Actual area coverage on foot and area estimation, instead of being related processes are probably independent processes and influenced by different variables. It is also found that irrespective of the amount of area covered in the room, the average estimation of the area of the room was surprisingly close to the actual area of the room. The actual area of the room was 225 square feet and the average estimated area was 214.583 square feet. It appears that area estimation is influenced by certain variables, environmental and/or physiological, other than color which help obtain more accurate perception of size. One such variable might be visuo-kinaesthetic perception. Zajaczkowska[19] has shown that it helps observers to estimate size accurately. His experiments required subjects to estimate visuallythe size of various distant objects while imagining

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[19] Zajaczkowska, A., "Ultra-Kinaesthetic Environmental Judgment of Size," Nature, March, 1967, p. 1270.

kinaesthetic activity in relation to them, and the size of their body members. Finally, the anthropometric measurements of the observer's body were taken. "The results showed that the estimates based on the imaginary tasks and on the observer's size given anthropometrically were better than the visual estimates by a highly significant amount. The visuo-kinaesthetic estimates were remarkably accurate in the case of several observers and, as expected, they depended neither on their perception of distance nor on K.[20] They were also independent of an observer's knowledge of the dimensions of his body." In the present study all the subjects had visuo-kinaesthetic perception and it might have helped them to estimate the size of the room accurately. More research, however, is needed on this and other variables influencing size estimation before more definite conclusions can be drawn.

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[20] K = Luneburg's curvature of space.

Summary

The aim of the present study was to demonstrate that a change in the color of an environment will bring a change in the pattern of human movement within that environment.

For this purpose two experiments were conducted. A display room at the museum of art, University of Kansas, Lawrence, Kansas, served as an experimental room. This room displayed fourteen Japanese paintings. Both experiments used two groups of subjects. For the first group of subjects, the room was colored light beige and for the second group of subjects, the room was colored dark brown. The color of the rug was approximately the color of the walls. All other variables in the room were kept constant throughout the period of experiments. Data on both experiments were collected simultaneously.

Movement data was collected by the Hodometer hidden in closet adjacent to the experimental room.

Experiment No. I used museum visitors as subjects who had no knowledge of the experiment. Only visitors coming singly, in two's and three's were included in the sample. In all there were 602 subjects, 301 in each group. The number of males, females, singles, pairs and trios in both groups was the same. The following movement measures were taken, evlevation, area, time, density and pace.

Experiment No. 2 used individuals especially brought to participate in the experiment and they were paid for this participation. There were 60 such subjects, 30 in each group. The number of males and females in

both groups was the same. The following movement measures for these subjects were obtained: elevation, area, time, density, pace, S.D. These subjects were sent in the room one at a time on the pretext that they were to look at the paintings and form their reactions to them to be reported to the experimenter later. After coming out of the room, they were given a three-question questionnaire. The first two questions were for the purpose of hiding the real aims of the study. In answer to the first question the subjects reported their reactions to the paintings; in answer to the second question they indicated their opinion whether or not the room was of appropriate size for the kind of display it had and the third question asked them to give their subjective estimate of the size of the room. Thus, in the second experiment, apart from movement measures, subjects' estimates of the area of the room were also available.

Both experiments had the same main aim stated in the beginning of the summary. Experiment No. 2, however, had two additional purposes. They were: 1) to see whether or not subjects especially brought to participate in the experiment produced movement patterns similar to those produced by natural museum visitors who had no knowledge of the experiment, and 2) to determine the subjective estimate of the size of the experimental room made by subjects, and to see whether or not their subjective estimates correlated with their movement patterns.

The research design for both experiments was the same and involved comparison of Group I and Group II on the measures taken.

The results indicated that museum visitors in Experiment I and individual subjects in Experiment 2 behaved differently. While the effect

of color was demonstrated on movement measures of subjects in Experiment 1, it was nonexistent in Experiment 2. So far as data of Experiment 1 are concerned, it was demonstrated that subjects in the dark brown room took more footsteps, covered more area and spent less time in the room, yielded a less dense movement pattern and showed a faster pace than subjects in the light beige room. Probably the variable "instruction" for subjects in Experiment 2 minimized the effect of color on their movement and room-size estimate. The fact that differential effect of color was demonstrated with museum visitors suggests that, 1) color does affect human movement, and 2) its effect is demonstrated when the organism is behaving naturally and is not aware of experimental controls.

The results indicated no relationship between movement measures and room-size-estimation. It was also demonstrated that irrespective of the amount of area covered on foot in the room, the average estimation of area was surprisingly close to the actual area of the room. Another significant observation was that although the two groups in Experiment 1 differed significantly in overall density of footsteps they in both experiments did not seem to differ appreciably in the distribution of density of footsteps.

Suggestions for Future Research

The present study has some obvious limitations. Future studies should overcome them. Some of the suggestions for future studies follow.

1. The subjects of the present study did not represent general population. They were either university students or people interested in higher educational, cultural etc. activities. Future studies should try to obtain a better representation of various segments or strata of population to enable wider generalization of results.

2. In future studies, the factor of "awareness of experimental setting" should be carefully controlled because this seems to affect behavior dramatically.

3. The present study was limited to only two colors. Future studies should use more color variations.

4. The present study seems to suggest that visuo-kinaesthetic perception helps in estimating size accurately. Future studies should try to determine relative influence of visual and kinaesthetic perception on size estimation. The results will suggest other interesting research possibilities in this area.

5. More correlational studies are needed investigating relationships between movement measures and other behaviors, perceptions, attitudes, preferences, emotional states, etc.

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Appendix A

EXPERIMENT #2

QUESTIONNAIRE TO SUBJECTS IN EXPERIMENT #2

Fill in the following:

Name_____ Age_____
Address_____ Sex_____

This experiment is in two parts. Please complete both parts of questionnaire.

Part I

This is a survey to compare the opinion of people about the art of different countries. You belong to a group of people whose opinion about the Japanese is sought. Write your comments in the space provided. Be as brief as possible in your comments.

Comments:

Part II

We are also interested in determining the appropriate size of the exhibition room for displaying different kinds of paintings. You are part of a group whose opinion is sought about the subjective estimate of the size of the room in which Japanese paintings are displayed.

Answer the following questions "yes" or "no".

Do you think that:

1. The room is too big_____
2. The room is too small_____
3. The room is of appropriate size_____

Following is a list of various estimates of the size of this room. Mark your own independent estimate of the size of this room and underline that estimate with which yours corresponds. If your estimate is other than the estimates listed below, write your estimate in the blank space.

1._____ 7._____

2._____ 8._____

3._____ 9._____

4._____ 10._____

5._____ 11._____

6._____ 12._____